Soil Science News and Views

Plant and Soil Sciences

2000

Soil Testing for Agronomic and Environmental Uses

William O. Thom
University of Kentucky, wthom@uky.edu

Frank J. Sikora
University of Kentucky, frank.sikora@uky.edu

UNIVERSITY OF KENTUCKY
COLLEGE OF AGRICULTURE
Lexington, Kentucky 40546-0091

COOPERATIVE EXTENSION SERVICE

Department of Agronomy

Soil Science News & Views

Vol. 21, NO. 4, 2000

SOIL TESTING FOR AGRONOMIC AND ENVIRONMENTAL USES

William Thom & Frank Sikora

Soil testing is a program that includes taking samples from a field or site, performing a laboratory analysis, and making recommendations for lime and crop nutrients. Good results from this program depend on several supporting factors: (1) obtaining samples representative of the soil in a field area or site; (2) using good techniques in the laboratory that give accurate indications of the nutrient status of the sampled area; and (3) having an extensive data base for making lime and nutrient recommendations from the analytical results.

Historically, soil testing has been used to assess the need for lime and fertilizer to optimize agronomic crop production. Recently, soil testing has been viewed as a means to predict a soil's ability to retain added nutrients against losses to lakes, rivers, streams and ponds through runoff or leaching. This publication will discuss the agronomic and environmental philosophies of using soil testing and the potential limitations of each philosophy.

Agronomic Soil Testing

Soil testing is a reliable, scientifically based method for assessing nutrient levels of soils relative to crop production. Nutrient recommendations from a soil test result may follow one of several philosophies. The **nutrient sufficiency** philosophy followed by the University of Kentucky recommends enough nutrient to satisfy the annual needs of a crop plus a small amount to gradually increase soil test levels. The **crop removal plus buildup** philosophy recommends nutrient levels to replace those removed by a crop plus a larger amount that more rapidly increases soil test levels. Fewer years are required to reach a high soil test level with this philosophy compared to nutrient sufficiency.

The nutrient sufficiency philosophy is dependent on an extensive research data base. The data for current soil testing methods came from research plots maintained over several years across the state using both farmers fields and research fields of the university. These plots examined different nutrient application rates on major soil types in the state. Researchers and specialists collected soil samples before and after cropping and sent them to the UK Soil Testing Lab for analysis. The lab used the same testing methods that are used for producer samples with the results going into the data base. Crop yields and soil samples, taken before nutrient applications and after cropping, were collected from the plots.

Analysis of the collected data led to the development of a critical nutrient level that is required for optimum crop yields given the weather conditions across many years. An **agronomic critical level** is the soil test level beyond which a crop yield response to any additional amount of a specific nutrient would not be expected.

Agronomic critical levels for P and K have been set for the major crops in Kentucky. The plant-available forms of N in soil change so rapidly that it is difficult to estimate how much N will be available to plants. Because a routine soil test for N does not exist, agronomic critical levels for N are not determined by soil test for making recommendations. Nitrogen nutrient recommendations, unlike P, K, and lime, are based solely on the crop to be grown, soil management, and soil moisture conditions. Like the recommendations for P, K, and lime, the N recommendations are based on years of field research.

Nutrient recommendations are based on the results of this field research. Yield responses to P and K application rates were assessed when soil test levels were below the agronomic critical level for these nutrients before cropping. Yield responses to varying N rates were assessed under various soil management and moisture conditions. These nutrient recommendations are published in AGR-1 (Lime and Fertilizer Recommendations) by the University of Kentucky.

Collectively, these nutrient and lime recommendations are designed to optimize crop yields each year with annual nutrient applications. The recommendations are based on soil test results from soil samples taken to a depth of 6 inches for conventional tillage and 4 inches for no-tillage. The P and K recommendations would likely take 4 or more years of annual applications to appreciably increase soil test levels. The recommendations in AGR-1 were developed from the research data base using current soil testing methods of the Soil Testing Laboratory of the University of Kentucky. These recommendations should not be used with other testing methods.

Environmental Soil Testing

There is a keen and widespread interest in using agronomic soil testing methods to predict nutrient loading, especially P, in runoff water leaving the land and going into lakes, rivers, and streams. Soil testing is but one factor that predicts the amount of P in runoff water. Phosphorus loss and movement from soil, and its bioavailability in water can be affected by such soil factors as pH, soil type, clay percentage, land roughness, slope, residue cover, tillage intensity, vegetative cover, and distance to a water body.

An **environmental critical level** of any nutrient is the level beyond which a soil cannot hold the nutrient from attaining some specified level in another part of the environment (such as ground or surface water). The value of this critical level will be much higher (from 2 to 10 times) than the agronomic critical level when soil testing is used as the indicator. Environmental critical levels should be derived from a data base generated from research as has been done for the agronomic critical levels. This research should include investigations on the soil's ability to sorb and retain applied nutrients, the ability of the nutrient to dissolve in water, the soil's ability to remove nutrients from flowing water, and the changes in nutrient forms in water that determine their availability to other organisms (bioavailability). This type of research has just begun at the University of Kentucky and at many other institutions.

Soil studied for this research should be analyzed by different laboratory methods than those that are used for analyzing soils for agronomic purposes. Several different methods have been proposed for environmental soil testing but only a few soils have been studied with these methods at this time. One factor clearly evident from this early research is that soils vary in the amount of nutrients they can retain. Research will need to continue for some time to develop an extensive data base before scientifically-based environmental critical levels can be established across the state. This research will involve laboratory evaluations and field plot research just as was required for agronomic uses.

Initial research from other states has found a positive relationship in some soil-crop landscapes between soil test levels of P and the level of bioavailable P in ground or surface water. Detailed evaluation of soil-crop-landscape combinations will require the use of more specific testing and evaluation methods to assess the potential risk of P reaching undesirable levels in aquatic environments.

Summary

Soil testing for agronomic crop production is a reliable, scientifically based method for predicting crop responses to nutrient applications. Establishment of agronomic critical nutrient levels and nutrient recommendations depends on an extensive research program and accompanying data base.

Even though environmental soil testing is in its infancy, some conclusions can be made about this type of testing. A soil test value alone will not be able to predict a field's impact on water quality, and establishing environmental critical levels will require extensive research. This is because of the many factors that control the release of nutrients from soil into the environment. However, a soil test value may identify fields that require additional evaluation of landscape and management factors to assess the risk they may pose to water quality.

William O. Thom
Extension Specialist

Cooperative Extension Service
U.S. Department of Agriculture
University of Kentucky
College of Agriculture
Lexington, Kentucky 40546

Official Business
Penalty for Private Use, $300

An Equal Opportunity Employer

PRSRT STD
POSTAGE & FEES PAID
USDA
PERMIT NUMBER G268